Comment submitted to Minerals Management Service (MMS)
By University of Delaware, College of Marine Studies

Re: 30 CFR Part 285, RIN 1010–AD30
Alternate Energy-Related Uses on the Outer Continental Shelf
Responding to: Advance Notice of Proposed Rulemaking (ANPR).

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This document constitutes comment on the MMS ANPR, per notification in the *Federal Register*, Vol. 70, No. 250, Friday, December 30, 2005, Proposed Rules, page 77345. The ANPR concerns portions of the Energy Policy Act of 2005, Section 388—Alternate Energy-Related Uses on the Outer Continental Shelf.

Introduction

This comment primarily addresses offshore wind power, for reasons given herein. We begin with a brief description of the offshore wind technology and resource. Both are very different from the resources now managed by MMS, and we feel these differences, if not accounted for, may lead to regulations imperfectly matched to this resource. Subsequent sections address specific questions asked by the ANPR. Other alternate OCS energy related technologies are reviewed in the final section.

I. Technology available today

This section briefly reviews the available offshore-class wind turbines, as we believe that an understanding of the technology may facilitate sound policy making.

Although offshore wind developments have been built in Europe since 1991, they have been based on smaller machines. We expect that the US offshore industry will use exclusively 3 MW and larger machines, with hub heights over 70 m. There are only two such machines fully specified and in service today:

- The General Electric 3.6 sl is operating at sea, with seven in service at Arklow Bank since June 2004. They are rated 3.6 MW at 14 m/s wind speed, with a blade sweep of 111 m diameter and about a 75 m hub height.

- The REpower 5M is currently the largest offshore-class wind turbine, producing 5MW at 13 m/s wind speed. It has a blade sweep of 126 m diameter and a hub height of about 90 m. Only one such unit is currently operating, at Brunsbüttel in Schleswig-Holstein, Germany (on land). Two REpower 5Ms are to be installed by

Talisman Energy, an oil and gas company, during summer 2006, adjacent to Talisman's Beatrice oil field, 25 km off the east coast of Scotland.

Other large, offshore-class machines are under development by Siemens, Vestas and other world-class wind turbine manufacturers. All current offshore designs are essentially scale-up versions of onshore designs, with allowance for salt water and wave loads. However, design constraints and opportunities are very different in the offshore environment, so in the time frame of 2-3 design iterations, MMS should expect changes in design assumptions and even layout of developments (e.g., centralized power conditioning). Global wind generating equipment sales for 2005 were €12 billion, or US$14 billion, which was over 11 GW nameplate capacity, an increase of 43% over the prior year (Global Wind Energy Council).

Support structures

Current offshore wind installations use cement base or monopile base support structures; these being limited to water depths of about 20 meters. The depth will be expanded by the new OWEC Jacket Quattropod. This platform was developed by the engineering design firm, OWEC Design AS, a jacket designer with 25 years experience in the offshore oil and gas industry. The OWEC Tower is currently under construction and will be installed in the North Sea this summer at a depth of about 50 meters. It has been validated for 50 m but is claimed to be usable and economically viable at depths to 100 m.

Although offshore oil and gas engineering has proven jackets for much deeper water, it does not appear to be economical at this time to place wind turbines on jackets at depths over 50-100 m. The revenue produced by a wind turbine is smaller per platform, as the wind resource is more spread out; thus jacket cost is a more dominant factor in the overall economics. Depth is critical to resource size, because deeper water structures extend the area available to developers, thus increasing the size of the offshore wind resource. This affects resource size in the US East and Gulf Coasts, and affects whether or not there is even a significant resource on the US West Coast. The US National Renewable Energy Laboratory (NREL) and others are working on preliminary designs for floating offshore wind platforms, but given the resource available at the 20 and 50 m depths, offshore wind can make a very large contribution to US domestic energy prior to development of floating platforms (see next section).

Thus, although 20 m is currently cited as the depth limit of offshore wind turbines, we recommend that MMS consider depths up to 50 m, and possibly to 100 m, to be potential for proposals within the next 3-7 years.

II. Resource Assessment

For offshore oil and gas, firms make expenditures for exploration to locate "sweet spots" of likely resource. The information thus developed may be proprietary, and may need to be guarded as part of the bidding process. The terrestrial wind resource has some similarity in that topographical features concentrate the wind in a few locations; however terrestrial wind data is mostly in the public domain, as are state maps of the terrestrial wind resource. The offshore wind resource is very different from both minerals (e.g. gas and oil) and from terrestrial wind.

We begin with fundamentals of the wind resource over the ocean and then address the match to electrical demand and energy markets.

Offshore wind power generators will operate entirely within the "Planetary Boundary Layer" (PBL), the lowest part of the atmosphere. The PBL behavior is directly influenced by its contact with the surface, with friction from the surface of the water (or land) transmitted upward. The wind resource of interest (as noted above) is at propeller hub heights, 80 to 100 m up, while most oceanic buoy anemometers are at 5 to 10 m. In recent publications, Prof. Richard Garvine and colleagues show that the wind at propeller height is of considerably higher energy content, and that the wind over the ocean is also much more energetic and steady than that over land. Because of much lower roughness of aquatic surfaces as compared to terrestrial ones, there is a much lower drag over the water. This decreased drag over the ocean means much higher winds in the PBL offshore, and hence more available power.

A map of one US offshore area, the Mid-Atlantic Bight, is shown in Figure 1.

Wind resource data offshore are in the public domain, and are available on NOAA web sites. Methods for extrapolating from anemometry height to turbine hub height have been published and Prof Garvine is publishing improved methods for offshore use, which also will be in the public domain (now under peer review). Wind data from ships is often also contributed to public records. All these data are used to improve weather forecasts, which are important for safety and economic reasons. Even the wind data collected by Cape Wind at the hub-height meteorological tower it constructed in Nantucket Sound at its expense is being continuously posted on the web for public access. Given the current division between investors, developers, and operators, it is essential that all have access to trustworthy wind data for due diligence on developer proposals. We recommend that MMS neither treat wind data as proprietary nor require a license to collect or use wind data. The resource data for wind is fundamentally different from geological data.

Distribution of wind energy in Mid-Atlantic Bight

Analysis of wind data on a number of estuarine and offshore buoys in the Mid-Atlantic Bight, and comparison with terrestrial wind data, offers some insight into the distribution of wind resource in the area.

- The wind resource increases significantly as you move from land, to estuaries, to offshore
- The wind resource is stronger and more consistent over water than over land

- The entire MAB, from near shore out beyond the depth limit of near-term bottom-anchored turbines, has nearly-uniform wind power; the entire region is one big "sweet spot", or more accurately, "sweet region"
- Power available from wind energy is higher during the wintertime, when the wind is blowing at higher speeds (compare inner and outer circles in Figure 1)

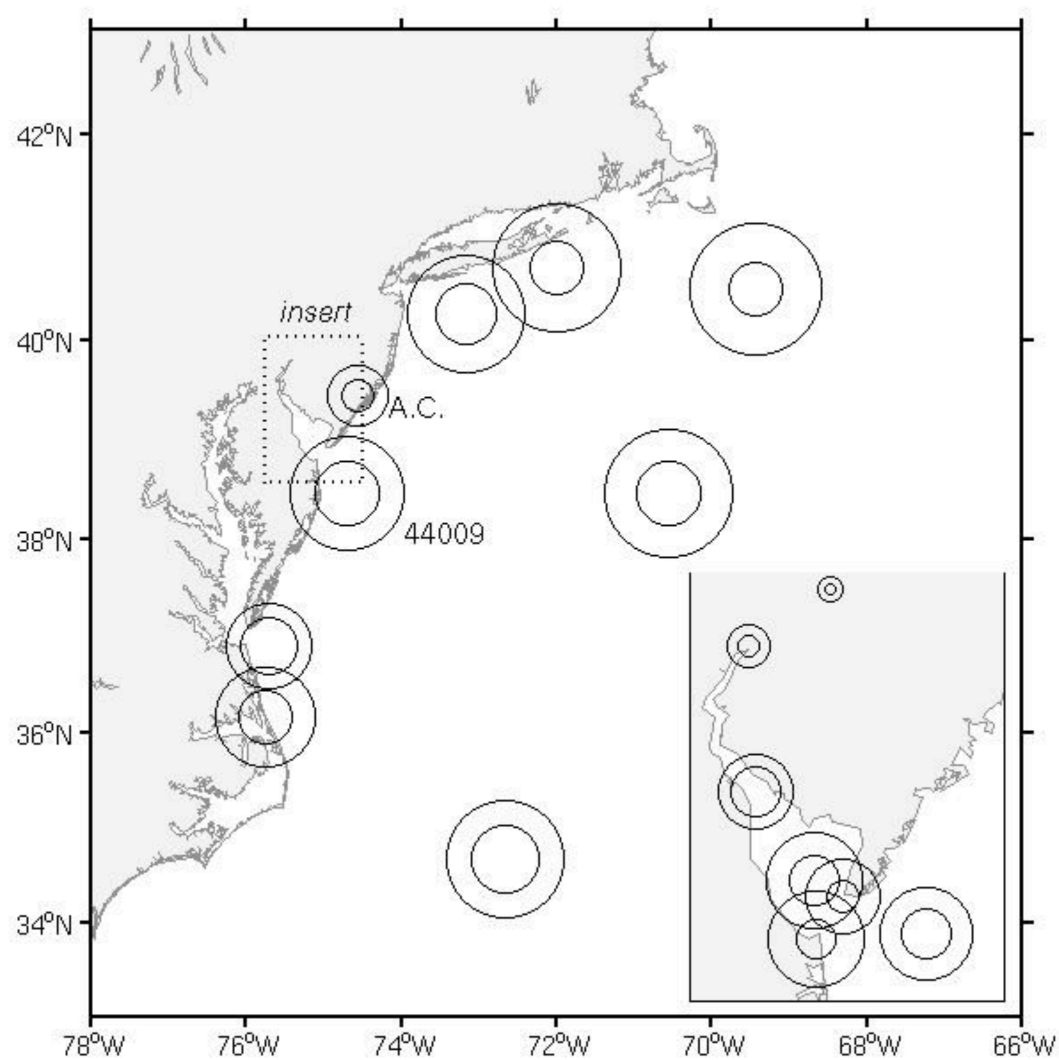

Figure 1. Distribution of wind energy in Mid-Atlantic Bight. The area of each circle is proportional to the power available. The scale in the inset is equal to that in the larger figure. The areas of the inner circles are proportional to the mean power over the summer and the outer for the winter.

To better compare terrestrial and ocean wind resources, we compare two wind measurement points in Figure 1. Based on three-year averaged hourly wind data at

Atlantic City (AC) and a nearby NOAA offshore buoy (EB44009), there was an average wind speed of 4.4 m/s for AC versus 8.2 m/s for EB44009 (see figure 2). Because the power of wind goes with the cube of the speed, the offshore winds have more power by a ratio of 551:85, or about 6.5:1. That is, there is over six times potential wind power offshore than at the nearby coastal site. (The methods used for this figure are an improvement over prior models and are also currently under peer review; full documentation should be available by mid-2006.)

The diurnal change at EB44009 is about 0.5 m/s versus about 3 m/s for AC. It is evident that winds are more prevalent and more consistent offshore and are less affected by diurnal variations. Some prior analysts have proposed that the coastal "sea breeze" would provide a good match to the daily load profile of peak electrical demand time. However, Figure 2 and the cube relationship suggest that the modest advantage of the near-shore sea breeze is overwhelmed by the much higher wind speeds offshore.

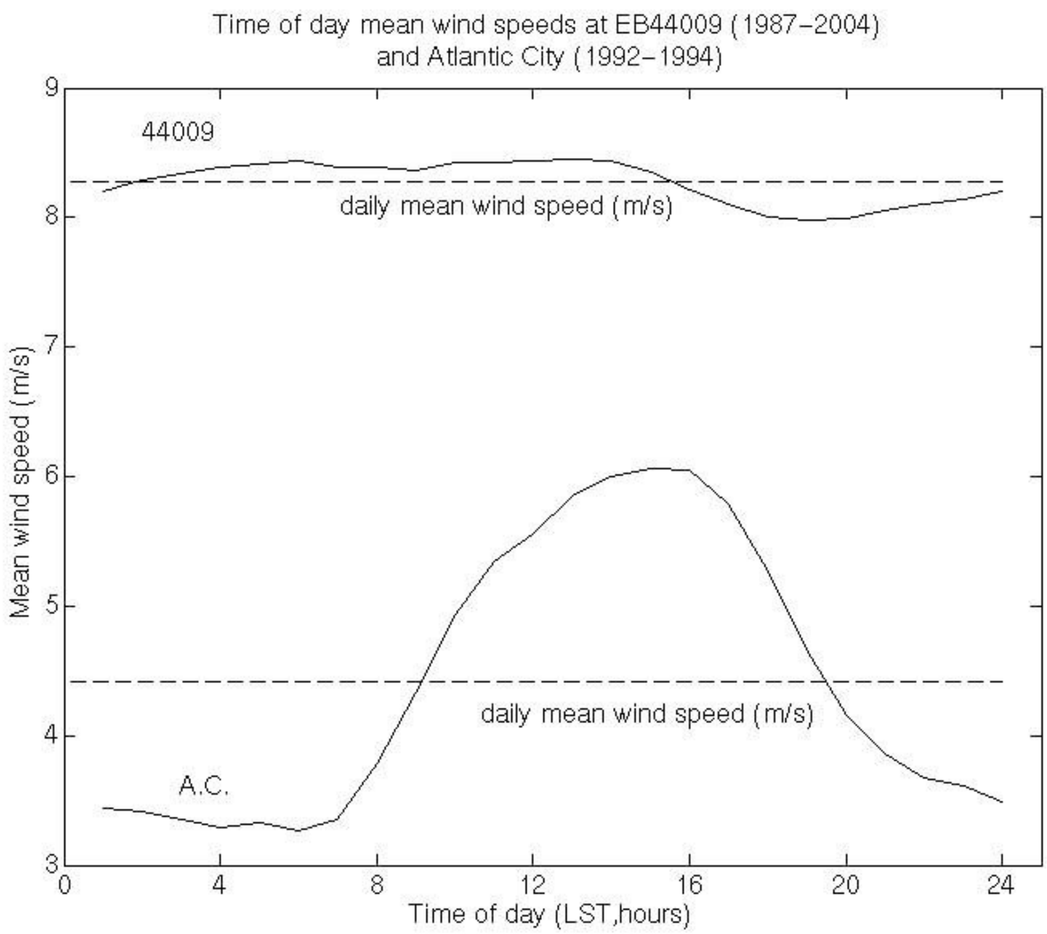

Figure 2. The daily variation in mean wind speed of NOAA buoy EB44009 versus Atlantic City

An Example Resource Assessment: Delaware

We have conducted a first-cut approximation (with multiple simplifications and not peer-reviewed) to determine the Delaware wind power resource out to 30 meters depth. As no comparable inventory has been done elsewhere in the United States, it may be useful as an illustration, but we caution that the numbers are preliminary. Excluding restricted areas, designated shipping lanes, and other possible conflicts (see below), we calculate a nameplate total 11 GW capacity for the Delaware Bay (state waters) and offshore (federal and state waters) to 30 m. The "nameplate power" is the total maximum generation capacity if each machine were operating at maximum output. When we evaluate the wind speed offshore, this nameplate capacity of 11 GW, becomes an actual average power output of 4 GW. For comparison, current Delaware power generation is 3.4 GW, all coming from the burning of fossil fuels. Based on existing hourly power market prices in Southern Delaware, matched hourly to the wind speeds, the revenue to a wind operator of this facility would be about $1 billion/year. Again, these are illustrative preliminary numbers for a single state, but since we find more electricity than the whole state requires, even without going to 50 m depth, this sample suggests that the US East Coast offshore wind resource may be very significant.

III. Access to OCS Lands and Resources

Phased Access

Overall MMS should be *flexible* on how it approaches certain development areas. For planning purposes and individual proposals, a phased access plan (similar to what BLM employs) would be beneficial. Also, whereas in some cases competitive bidding contracts are clearly needed, there will most likely be times when developers or proposals face no competition. For example, under a testing facility phase there is likely no need for a competitive bidding contract, unless of course a developer would want preferential rights to the area after testing is complete. MMS should understand that different scenarios will arise, and should be flexible in how it handles different development situations. MMS should also consider a lease and royalty-phasing plan. Presumably a developer would pay lease payments for the land he holds, and as the project gets underway and begins to make economic returns, royalties can be adjusted accordingly.

Exclusion of other activities

The ANPR raises the question of whether to exclude "other" activities from the area in which alternative energy projects are developed. As far as offshore wind power is concerned, assuming wind machines with bottom mounting, we do not believe that there is any need to exclude other activities. Activities that could be carried out within a wind farm include commercial and recreational fishing, recreational boating and sailing, pleasure boats and tour boats (see below for conflicts with other ocean energy devices). Assuming some thought in design, there is unlikely to be conflicts with mariculture, fish habitat, wave energy, OTEC, and ocean current energy. Due to the size of commercial vessels, MMS may consider restrictions of oceanic commercial shipping in order to reduce the risk of property damage to both ship and tower structure.

Target area

As a starting point for offshore wind development, we suggest that MMS consider the mid-Atlantic to Northeast region for a number of reasons: the waters extending off the continental shelf are relatively shallow, thus allowing for near-term development in a large area despite limitations of currently-deployed technology to 20 m water depth; wind development would take place close to large electrical load centers; higher latitudes (from Cape Hatteras North) pose less of a hurricane threat to wind turbines (today's technologies are vulnerable to Category 4 and 5 hurricanes, although this is likely to be corrected in the next generation of designs); and interconnection of sites along the Northeast should reduce intermittency, although this has not yet been empirically demonstrated.

IV. Comparative Impacts

A. Environmental Impacts

Offshore wind projects have negative environmental impacts. However, research suggests that their environmental costs are in most cases outweighed by their public benefits, typically by very large margins (e.g. Jarvis 2005). When preparing environmental evaluations for such developments, MMS should ensure the EIS is broadly conceived so as not to focus solely on impacts from a proposed wind farm. Indeed, in addition to considering alternatives sites to locate the offshore wind farm and their relative merits, the heart of the analysis should focus on the question, *"What are the relative environmental costs and impacts of offshore wind power generation compared to other methods of producing electricity?"* In other words, the environmental impacts that result from wind power should not be viewed in isolation, but rather need to be considered relative to the impacts from other forms of energy production (See e.g., the BLM EIS, 2005; Jarvis, 2005; European Community, 2003, in which comparisons are made on a number of metrics including, noise; human health impacts and environmental justice; wildlife and ecosystem effects; land disturbance; waste generation; and greenhouse gas production). One straightforward way of comparing offshore wind with other electricity production facilities is on an impact per MWh of electricity produced, or projected to be produced. Below, we provide two examples: impacts to birds and fisheries.

Birds

While avian and bat collisions with wind turbine rotor blades are a recognized impact of terrestrial wind facilities and the potential for avian collision with offshore wind facilities warrants MMS's thoughtful consideration, these impacts may be reduced offshore as has been demonstrated in operating offshore wind farms in Europe. For example, a radar study of duck and geese migrations in proximity to an offshore wind farm in Denmark has shown that most of these birds fly *around* the wind turbines. The radar data indicates that at most 0.9% of night migrants and 0.6% of day migrants are at risk of collision with turbine blades, and these percentages are probably over-inflated as some birds fly over or under the blades, or are unharmed through the sweep area (Deshol & Kahlert, 2005).

Fisheries

Fishery impacts from offshore wind have been identified, for example, in the Cape Wind EIS and in the Interim Report of the NJ Blue Ribbon Panel. This is another example of the need to give comparative data with other power generation impacts. Compared with Cape Wind's limited mortality on fish species (and this during the construction phase only), approximately *16 billion fish eggs and larvae are killed annually* from impingement and entrainment at the single nearby Brayton Point coal power plants (Jarvis 2005). The Brayton Power Plant also has been estimated to reduce winter flounder catch by 70-140 metric tones per year (Jarvis 2005, p. 199). Other impacts of competing power sources include the effects of acid precipitation and heavy metal contamination, although not quantified in the literature, are known to have long-lasting effects on wildlife species, including habitat exclusion, physical impairment, and reduced breeding potential" (Ibid).

In sum, future EIS should not be done like that for Cape Wind, which itemized the potential for dozens or hundreds of fish kills once during construction, yet never mentioned the loss of billions of eggs and larvae, nor the loss of 70-140 metric tons of commercial catch, both yearly losses resulting directly from a decision to not build the wind facility in question. To produce such EIS does not inform public debate (see section V below), rather it paints a picture that is misleading in the extreme.

External costs

The European Commission study on external costs of electricity production found wind energy was second only to hydro energy as producing the least socio-environmental damage. The study estimated wind produces 0.16 € cents per kWh in quantified marginal external costs of electricity production in Germany, compared to 2.35 € cents/kWh from coal, 1.08 € cents/kWh for gas, and 0.11 € cents per kWh for nuclear energy (European Commission, External Costs: Research Results on Socio-environmental damages due to electricity and transport, 2003).

B. Economic considerations

Wind power requires more labor per megawatt generated than any other method of electric power generation. The Cape Wind project is estimated to result in an annual permanent increase of 154 new jobs, and many new jobs would be created during the manufacture, assembly, and construction as well (Cape Wind DEIS).

Some argue that wind power is not economically feasible or efficient because of the subsidies it receives. Over the entire course of wind power's development in the United States through the year 2000, it was estimated that wind power subsidy amounted to 4 cents/kWh. For a like-metric comparison, we compare subsidies at similar phases in development. Over their comparable first 15-year period of use, nuclear power received a 1530-cent/kWh subsidy, while wind power received only a 46-cent/kWh subsidy. And over the first 25-year period, nuclear energy received a 66-cent/kWh subsidy while wind power received a 4-cent/kWh subsidy (see Renewable Energy Policy Report, 2000). So by historical standards, wind is not receiving a large subsidy (although the subsidy for nuclear, given a long period of development and operation, is low today, only 1.2 ¢/kWh.)

In sum, offshore wind power will have environmental impacts and it currently receives a subsidy. When MMS facilitates or requires impact statements regarding offshore wind, we recommend that appropriate comparisons be included, as suggested in our examples above. Without such comparisons, especially when offshore wind will displace or obviate the need for other technologies, assessments examining the impacts of wind in isolation are misleading and may lead to poor decisions.

V. Public opinion regarding offshore wind (using as an example the Cape Wind project in Nantucket Sound)

How should one interpret the publicized local opposition to the offshore wind development in Nantucket Sound? We conducted on-site ethnographic interviews (See Kempton and Firestone, 2005) and a mail survey to 1500 randomly selected names from Cape Cod, Nantucket Island, and Martha's Vineyard (see Firestone and Kempton, 2006). We obtained a 38.5% response rate (191 surveys were returned as undeliverable, and 504 were returned as completed surveys). The motivating factor of the research was to determine whether opposition and support for offshore wind power is based on well-reasoned judgments about the benefits of wind power versus the negative environmental impacts, or whether it is based on other factors. For example, is opposition to offshore wind power short-sighted and selfish, as often portrayed in stereotyping statements like "wealthy homeowners just want to protect the value of their coastal property."

We found that the majority of Cape Cod residents expect negative impacts from the project, with a much smaller percentage expecting positive effects. The most frequently mentioned factor identified as affecting one's position was marine life/environmental impacts, followed by electricity rates, aesthetics, and fishing and boating impacts. Supporters were much more likely to believe that the project will have positive impacts on electricity rates and job creation. Opponents were much more likely to see the project as having negative impacts on the local fishing industry, recreational boating, property values, and birds and other marine life. Both supporters and opponents found commonality in believing there would be a negative impact on aesthetics and community harmony and a positive impact on air quality.

When survey respondents' expectations are compared with the findings of scientific studies, we observed that many of the beliefs upon which opinion are based were inconsistent with those scientific studies. This suggests that there is pertinent misinformation out there, and better information on electricity rates, wildlife impacts (marine life and birds), air quality improvements, and job creation is likely to influence the public's perception of offshore wind. For example, 40% of opponents in the survey stated they would be more likely to support the Cape Wind project if there was no serious harm to marine life; 39% said they would if the project created jobs; 48% would if air quality improved; 52% would if electricity rates decreased; and 53% would if Cape Cod received the generated electricity. On the other hand, 72% of respondents supporting the Cape Wind project stated they would be more likely to oppose if there were to be serious harm to bird life. A few further points from the survey: about 8% of opponents (and 13% of respondents overall) would be more likely to support the Cape Wind project if it were undertaken by a local government rather than a private developer and 33% of opponents (and 39% overall) would be more likely to support the Cape Wind project if it were out of sight by moving it further out to sea. Perhaps, most revealing, if the Cape Wind project was the first part of a large scale implementation strategy, 19% of opponents (and 36% overall) would be more likely to support the project. This suggests that there is a willingness to accept the downside (such as aesthetic affects) of offshore wind power development and even to be the first community to be so affected provided that offshore wind power is transformative.

In sum, we recommend that MMS evaluate expressed public opposition to, and support for, specific projects in the context of what is known by the public and what are the sources of opposition and support, rather than taking statement of preference or concern at face value.

VI. Other Offshore Renewable Energy

We very briefly review other offshore renewable energy resources, as they are included under the scope of MMS's new authority under Energy Policy Act of 2005, Section 388. These other alternative uses include: Ocean thermal, tidal, wave, and ocean currents. References can be provided on request.

Ocean Thermal

Thermal gradients in the ocean represent a vast energy resource, and several attempts to harness it were made by the US in the 1970s and 1980s. The resource is strongest in warmer waters, such as Florida's Atlantic Coast, the Gulf of Mexico, and Hawaii. The prototype devices were referred to as OTEC for Ocean Thermal Energy Conversion. Tests, including those on large-scale OTEC devices (e.g., off Hawaii) failed to develop a practical approach to tapping ocean thermal energy. Problems included fouling, various engineering problems, and unanswered questions of the environmental effects of exchanging warm surface waters with cool deep waters.

Tidal

Tidal energy conversion appears to be cost-effective in the near- to intermediate-term. A good deal of work is being done in the United Kingdom, where the British Isles themselves channel a large tidal flow in and out of the North Sea. In the United States, strong tidal forces are available in very few locations, and we find no resources outside of the 3 nm limit of state waters.

Wave

Several approaches to wave energy are being tested, including floats with reciprocating generators, and articulated "worms" with piston compression of fluids used internally to turn a turbine. A plausible case can be made for their economics. They are surface floating and most are moored. EPRI is involved in testing some devices off the California coast. Wave power proponents tout the low visibility profile of this technology over offshore wind. However, large areas of ocean surface are used, and potential conflicts with navigation and fishing may be significant but are not yet documented.

Ocean current

There are no built prototypes of devices to capture ocean current energy. Nevertheless, a large resource exists off the SE US Coast, from Florida to North Carolina. We are carrying out an analysis of basic oceanographic and engineering issues, but the resource in this region appears to be several times the power use of the entire United States, and in terms of power density, the Gulf Stream at 1 m/s has the power equivalent of a steady wind of 19 m/s, nearly constant 24/365 (compare with wind velocities in Figure 2, above). Preliminary designs by entrepreneurs illustrate that technology development for these devices achieve a large head start because most of the components draw from experience with wind power and submarines—little new technology is needed. Depths would be below that of surface navigation but could conflict with submarine passage or certain ocean species. Because no devices exist and no environmental assessment, or even scoping, has been done, ocean current should be considered speculative. However, due to the resource size, seemingly extremely favorable economics, and potential for near-term device development, we encourage MMS to facilitate any prototype or pilot applications to test exploitation of this resource.

None of the above technologies pose sea-space conflicts with offshore wind. In particular, tidal generators would be nearer to shore while ocean current generators would be placed at depths of over 50 meters. And wave generators could be synergistically collocated with wind. However, the wave generators would probably impose restrictions on navigation and fishing that the wind operator might not want. Currently, we see no reason for MMS to develop rules concerning conflicting space needs for these various renewable energy technologies.

Additional resources on offshore wind power, and many of the references cited here, can be found at our web site: http://www.ocean.udel.edu/windpower

Respectfully Submitted,

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